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ABSTRACT

In early 2000, an assessment of mathematics achievement and related school practices was carried out in 24 clusters of rural high schools and their feeder middle schools in seven states. More than 2,400 eighth-graders and more than 1,900 12th-graders took a mathematics achievement test referenced to the National Assessment of Educational Progress and concurrently, completed a survey about their overall school experiences, including experiences specifically related to their mathematics classes. The results provide evidence that many students enter high school unprepared for a rigorous college-preparatory mathematics curriculum, and many students graduate from high school without the mathematical skills and knowledge needed to compete for "good jobs" or to enter postsecondary programs without remediation. Fewer 12-graders than 8th-graders performed at the proficient level and above, meaning that these rural schools lost ground with many students in high school. Course-taking patterns were related to mathematics achievement. African American students had lower mathematics achievement than White students, but the racial achievement gap narrowed when all students were held to the same rigorous standards and took the same higher-level courses. These schools placed little emphasis on rich numeracy experiences across the curriculum, had low expectations for many students, and failed to provide the guidance and support students need to succeed in higher-level math courses. Recommendations are offered for improvement. (Contains 15 data tables) (Author/SV)

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HIGH SCHOOLS THAT WORK

Research Brief

SREB

MAKING MIDDLE GRADES WORK

MAKING SCHOOLS WORK

Factors Affecting Mathematics Achievement for Students in Rural Schools

by Gene Bottoms and Kathleen Carpenter

Key Findings for Rural Schools

The 2000 eighth-grade mathematics assessment data provide evidence that many students *enter* high school unprepared for a rigorous college-preparatory mathematics curriculum. Similarly the 2000 high school mathematics assessment data indicate that many students graduate from high school without the mathematical skills and knowledge needed to successfully compete for the "good jobs" in today's economy or to enter postsecondary programs of study without remediation in mathematics.

- Fewer 12th-graders than eighth-graders perform at the Proficient level and above — meaning that these rural schools are losing ground with many students in high school.
- Course-taking patterns matter. Taking at least a semester of algebra in the middle grades and four years of rigorous mathematics courses in high school translates into higher achievement in mathematics for all students.
- The achievement gap between White and African-American students narrows when African-American students are held to more rigorous standards and take higher-level courses.
- These schools place little emphasis on rich numeracy experiences across the curriculum, and high expectations and quality student work in all classrooms and for all students.
- These schools fail to provide many of their students with the levels and kinds of experiences, such as guidance, extra help and support needed to enter and succeed in higher-level mathematics courses.

In early 2000 the Southern Regional Education Board's (SREB) middle grades and high school improvement initiatives conducted research into mathematics achievement by assessing more than 2,400 eighth-graders and more than 1,900 12th-graders in 24 clusters of rural high schools and their feeder middle grades schools in seven states. The exam used was referenced to the National Assessment of Educational Progress (NAEP). Concurrently, these students completed a survey about their overall school experiences, including experiences specifically related to their mathematics classes. The purpose of this study is to answer three questions:

- What is the mathematics achievement of eighth- and 12th-graders in a cluster of rural schools?
- What is the relationship between course-taking patterns and mathematics achievement?
- What is the relationship between certain school and classroom practices and mathematics achievement?

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How Can You Get More Students To Perform at the Basic and Proficient Levels in Mathematics?

Based on this study of rural schools,

- Have more students complete "real" Algebra I in the middle grades.
- Enroll all ninth-graders in college-preparatory mathematics.
- Require four years of mathematics in high school for **all** students.
- Expand students' opportunities to use mathematics in other classes.
- Provide struggling students with quality instruction and extra time and help to meet standards.
- Increase the level of mathematics instruction to reflect higher standards and more engaging activities.
- Implement a guidance program that informs parents and students about why students need to take college-preparatory mathematics.

Mathematics Achievement of Eighth- and 12th-graders

The mean score of the eighth- and 12th-graders in these 24 rural schools is at the Basic level; however, the 12th-graders are on the brink of falling below the Basic level in mathematics achievement. (See Table 1.) Eighth-graders had a mean mathematics score of 151 — eight points higher than the lower threshold of the Basic level. (At the eighth grade level, Basic ranges from 143 to 177.) However, 12th-graders had a mean mathematics score of 297 — right at the lower threshold of the Basic level. (At the 12th grade level, Basic ranges from 297 to 327.)

Table 1
Mean Mathematics Scores and Performance Levels of Eighth- and 12th-Graders

	All Students		White Students		African-American Students	
Grade Level	**8th**	**12th**	**8th**	**12th**	**8th**	**12th**
Mean Score	151	297	157	301	132	285
Below the Basic Level	39%	39%	32%	34%	61%	61%
Proficient Level or Above	22%	13%	25%	15%	7%	5%

Shaded cells indicate scores below the Basic level.

Nearly twice as many African-American students perform below the Basic level in mathematics achievement as do White students — 61 percent for African-American students as opposed to 33 percent for White students. Of the more than 2,400 eighth-graders, 68 percent are White, 18 percent African-American and 14 percent of various other ethnic and racial groups.[1] Of the more than 1,900 12th-graders, 77 percent are White, 16 percent African-American and 7 percent of various other ethnic and racial groups.

An examination of the eighth- and 12th-grade data regarding gender reveals that there is no statistically significant gap in mathematics performance between male and female students. But too many students of both genders are scoring below the Basic level and too few at the Proficient or Advanced levels.

It appears that the quality, rigor and the amount of time devoted to mathematics curriculum and instruction in these high schools is inadequate to reduce the percentages of students performing below the Basic level, even though many lower-achieving students drop out of high school. Whites increase their percentages of students falling below the Basic level, and African-American students retain their alarming rate of 61 percent below the Basic level in mathematics achievement. (See Table 1.)

These high schools are failing to sustain the number of students at the Proficient level or above. In grade eight 22 percent of the students are at the Proficient or Advanced levels compared to 13 percent in grade 12. (See Table 1.)

[1] Students in the "Other" race/ethnic category include American-Indian, Asian, Hispanic and Native Hawaiian/Pacific Islander students. None of these groups has significant numbers of students used for analysis in this study.

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The Relationship between Course-taking Patterns and Mathematics Achievement

The 55 percent of all students who reported taking a semester or more of algebra in the middle grades have a mean mathematics score of 160 — the midpoint of the Basic range. Access to rigorous mathematics coursework in the middle grades is measured by whether or not students take algebra — the gateway to higher mathematics. In contrast, students who did not take algebra in the middle grades have a mean score of 141 — two points below the Basic level. (See Table 2.) For African-American students who took algebra in the middle grades their mean score is lower (below the Basic level) than White students who did *not* take algebra in the middle grades (within the Basic level range).

One challenge at these rural middle schools is to close the achievement gap between African-American students and White students. Another challenge at these middle schools is to have *all* eighth-graders either complete "real Algebra I" or be ready for it in grade nine. At least one third of eighth-graders did not have rigorous enough mathematics coursework in the middle grades to prepare them for Algebra I in grade nine. Almost one-third of the 12th-graders reported taking at least one mathematics course below college-preparatory Algebra I in high school. Students who take one or more low-level mathematics courses in high school tend to fall further behind in mathematics achievement.

Table 2
Eighth-grade Course-taking Patterns and Mathematics Achievement by Race/Ethnicity

	All Students	All White Students	All African-American Students
Percentage of Students with Algebra in the Middle Grades	55%	57%	54%
Mean Score of Students with Algebra in the Middle Grades	160	165	138
Mean Score of Students with No Algebra in the Middle Grades	141	147	124

BASIC
143 - 177

PROFICIENT
178 - 209

ADVANCED
210 and above

Shaded cells indicate scores below the Basic level.

Students who went beyond the recommended mathematics curriculum had significantly higher mathematics achievement with mean scores ranging from 312 to 322. (See Table 3.) However, 12th-graders who completed the recommended high school mathematics curriculum[2] have a mean score of 296 — one point below the Basic level. White students have a mean score of 301 — just within the Basic range, while African-American students have a mean score of 282 — well below the Basic level. In contrast, those students who did not complete the recommended high school curriculum have mean scores from 266 to 284 — significantly below the Basic level. African-American students who complete the recommended curriculum have nearly the same mean scores as White students who complete less than the recommended curriculum — both are below the Basic level. Only the 16 percent of African-American students who went beyond the recommended mathematics curriculum had a mean score (312) within the Basic range. Graduates performing well below the Basic level are at risk of not being able to pass employers' exams or of being required to take remedial mathematics courses in postsecondary educational programs. The challenge for these rural high schools is to teach all students to higher standards.

[2]The recommended curriculum for high school is at least three credits in mathematics, with at least two of those credits being at a college-prep level. The recommended curriculum for middle grades is either completing college-preparatory Algebra I before grade nine or entering grade nine prepared for college-preparatory Algebra I.

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Table 3
12th-grade Course-taking Patterns and Mathematics Achievement by Race/Ethnicity

	All Students	All White Students	All African-American Students
Students Completing Less Than the Recommended Curriculum	19%	20%	17%
Mean Score of Students Completing Less Than the Recommended Curriculum	278	283	266
Students Completing the Recommended Curriculum[3]	53%	49%	67%
Mean Score of Students Completing the Recommended Curriculum	296	301	282
Students Completing More Than the Recommended Curriculum[4]	28%	31%	16%
Mean Score of Students Completing More Than the Recommended Curriculum	321	322	312

BASIC
297 - 327

PROFICIENT
328 - 348

ADVANCED
349 and above

Shaded cells indicate scores below the Basic level.

Both middle grades and high school teachers appear to have two sets of standards — one for White students and another for African-American students who take the same courses. Middle grades schools are enrolling about the same percentages of African-American and White students in some type of an algebra course; yet there are significant differences in achievement. African-American students are more likely than White students to take lower-level algebra courses in high school and less likely to take higher-level mathematics courses, such as pre-calculus. (See Table 4.) **If opportunities for excellence and rigor in mathematics instruction have any meaning it must mean the same thing to all students.**

Table 4
12th-graders Completing Mathematics Courses by Race/Ethnicity

Students Who Said They Completed the Following Courses	White Students	Mean Score-White	African-American Students	Mean Score-African-American
Basic Algebra I	21%	291	37%	276
College-preparatory Algebra I	69%	306	62%	285
Pre-calculus	29%	322	15%	309

Shaded cells indicate scores below the Basic level.

[3]For the purposes of this table, students who completed the recommended curriculum completed three or four mathematics courses, with at least two at the college-preparatory level (Algebra I, geometry or through Algebra II). This group does not include students taking more than the recommended curriculum.

[4]This group of students consists of those who completed at least four mathematics courses including pre-calculus/calculus, Algebra III or Trigonometry.

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High Expectations and Mathematics Achievement

In addition to increasing students' access to higher-level mathematics courses, schools and teachers can take steps to establish high expectations and the necessary support to help students meet them within mathematics classrooms. High expectations send a clear message to students that learning is the goal of schooling, that *all* students can learn and that support to meet high expectations is available for everyone.

Middle grades and high school students who report that they experience moderate to high expectations in their classes have significantly higher mathematics achievement than students who do not report this. (See Tables 5 and 6.) From the data in Table 5, 67 percent of middle grades students report that they were in such classrooms as compared to 59 percent of high school students. (See Table 6.) The eight percent of middle grades students who say they experience high expectations in their classes has a mean mathematics score of 161 — at the mid-level of the Basic range. In contrast, a third of all students report that they experience low expectations in their classes. They have a mean score of 142 — one point below the lower threshold of the Basic level. There is little difference between middle grades African-American and White students' perceptions regarding the level of expectations they experience in their classes. **However, eighth-graders whose parents had not gone beyond high school are more likely to find themselves in classrooms in which they experience low expectations.**

Table 5
Expectations of Eighth-graders by Race/Ethnicity and Parent Education

	Low Expectations (0 to 1)[5]	Moderate Expectations (2 to 4)	High Expectations (5 to 6)
All Students	33%	59%	8%
Mean Score	142	155	161
All White Students	33%	58%	9%
All African-American Students	34%	60%	6%
Students with Low Level of Parental Education[6]	36%	56%	8%
Students with High Level of Parental Education[7]	28%	62%	9%

Shaded cells indicate scores below the Basic level.

[5]For the purpose of this study, the numbers in the parentheses refer to the list of the six indicators for high expectations at the middle grades level and to the five indicators at the high school level. See sidebar on page 6. For example, "0 to 1" in Table 5 means zero to any one of the six indicators listed for the middle grades, while "0 to 1" in Table 6 means zero to any one of the five indicators listed for the high school, and so on.

[6]For the purpose of this study, high school students with a "low level of parental education" are those who indicated that neither of their parents attempted education after high school or who responded, "I don't know." Middle grades students with a "low level of parental education" are those who indicated that their mother attempted no education after high school or they responded, "I don't know."

[7]Students with a "high level of parental education" are those who indicated that at least one of their parents had some education after high school.

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High school students who report they experience moderate to high expectations in their classes have a mean mathematics achievement score within the Basic level range. In contrast, students who report they experience low expectations in their classes have a mean score of 295 — two points below the Basic level. **Low expectations translate into lower achievement and high expectations translate into higher achievement.**

Table 6
Expectations of 12th-graders by Race/Ethnicity and Parent Education

	Low Expectations (0 to 1)	Moderate Expectations (2 to 3)	High Expectations (4 to 5)
All Students	41%	44%	15%
Mean Score	295	301	302
All White Students	43%	44%	13%
All African-American Students	37%	47%	16%
Students with Low Level of Parental Education	42%	45%	13%
Students with High Level of Parental Education	41%	43%	16%

Shaded cells indicate scores below the Basic level.

Middle Grades Indicators of High Expectations

- My teachers often encourage me to do well.
- Teachers set high standards and are willing to help me meet them.
- My teachers often indicate the amount and quality of work necessary to earn a grade of A or B.
- I often revise my essays or written work several times to improve its quality.
- I often work hard to meet high standards on assignments.
- I spend at least one hour on homework each day.

High School Indicators of High Expectations

- My teachers often indicate the amount and quality of work necessary to earn a grade of A or B.
- I spend at least one hour on homework each day.
- I often revise my essays or written work several times to improve its quality.
- I often work hard to meet high standards on assignments as part of a team.
- My teachers are frequently available for extra help before, during or after school.

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What Can Schools Do to Increase the Percentages of Students Performing At or Above the Basic Level?

In both the middle grades and high school:

- Require students to redo their work until it meets standards.
- Have teachers make it clear to students what is required to earn a grade of A or B.
- Have teachers agree on student work and exam items that represent Basic and Proficient levels of understanding. (See descriptions on page 17.)
- Have middle grades and high school mathematics teachers work together to develop exams and criteria for portfolios of student work that represent either readiness for Algebra I or that students have met the standards of "real Algebra I."

In the middle grades:

- If not all students take college-preparatory Algebra I in the middle grades, require the remaining students to exit the middle grades prepared to enter college-preparatory Algebra I in grade nine.
- Increase by 25 percent each year the percentage of students completing college-preparatory Algebra I before grade nine.

In high school:

- Require all students to complete college-preparatory Algebra I, Algebra II, geometry and higher-level mathematics courses, including at least one mathematics course during their senior year.
- Eliminate mathematics courses that award credit for content below the level of college-preparatory Algebra I.
- Require students entering high school who are not ready for college-preparatory Algebra I to enroll in a catch-up mathematics course during the summer and the first half of the ninth grade for elective credit.
- Have high school teachers, postsecondary mathematics teachers and employers work together to develop exams and criteria for portfolios of student work that represent readiness for postsecondary studies and/or employers' exams.

Numeracy Experiences in the Middle Grades and High Schools and Mathematics Achievement

This is an age of data information — presented to us in the form of graphs, charts and statistics. Numbers and quantities control our decisions about almost everything — education, health, government, etc. Employers are dismayed by prospective job candidates' lack of quantitative skills while postsecondary institutions are forced to offer a variety of remedial mathematics courses. These conditions translate directly into providing more students with "numeracy-rich" learning experiences in the middle grades and in high school. Numeracy not only includes knowledge of fundamental skills in mathematics, but also knowing when and how to use technology, making appropriate predictions from displays of data, and explaining reasoning. With this in mind, the numeracy indicators for this study are intended to combine key elements of mathematics course content with assignments that extend quantitative thinking beyond the mathematics classroom and have students explain, reason, make predictions and draw conclusions.

Students who have somewhat frequent to frequent numeracy experiences score significantly higher in mathematics achievement at both the middle grades and high school levels than students with infrequent numeracy experiences. (See Tables 7 and 8.) Too few students at either the middle grades or high school level — 10 percent and 22 percent respectively — have frequent numeracy experiences.

Middle Grades Numeracy Experiences

- I complete mathematics problems from a textbook daily.
- I do mathematics assignments with a partner at least once a week.
- I use a scientific calculator to complete mathematics assignments at least once a week.
- I use mathematics to solve problems in other classes at least once a week.
- I create tables, charts and graphs often to complete assignments. (asked about all classes)
- I completed at least a semester of algebra in grade six, seven or eight.
- I completed advanced classes in mathematics.

High School Numeracy Experiences

- I completed a semester or more of algebra in the middle grades.
- I had the necessary knowledge and skills in mathematics to succeed in college-preparatory-level courses in high school.
- My academic and career/technical teachers work together to help me improve my mathematics skills.
- My mathematics teacher shows me how mathematical concepts are used to solve real-life problems.
- I use mathematics to complete challenging assignments in my vocational area.
- I use database or spreadsheet software to complete an assignment or project.
- I use a graphing calculator to complete mathematics assignments.
- I orally defended a process I used to solve a mathematics problem.
- I worked with one or more students in my class on a challenging mathematics assignment.
- I worked in groups to brainstorm how to solve a mathematics problem.

Table 7
Numeracy Experiences of Eighth-graders by Race/Ethnicity and Parent Education

	Infrequent Numeracy Experiences (0 to 2)*	Somewhat Frequent Numeracy Experiences (3 to 5)	Frequent Numeracy Experiences(4 to 5)
All Students	30%	60%	10%
Mean Score	140	154	169
All White Students	31%	59%	10%
All African-American Students	32%	61%	7%
Students with Low Level of Parental Education	32%	60%	8%
Students with High Level of Parental Education	27%	61%	12%

Shaded cells indicate scores below the Basic level.

*For the purpose of this study, the numbers in the parentheses refer to the list of seven numeracy experiences at the middle grades level and to the 10 numeracy experiences at the high school level. See sidebar on page 8. For example, in Table 7, "0 to 2" means zero to any two of the seven numeracy experiences at the middle grades level, while in Table 8, "0 to 3" means zero to any three of the 10 numeracy experiences at the high school level, and so on.

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High school students with a somewhat frequent level of numeracy experiences have a mean score (295) higher than students with infrequent numeracy experiences (285). (See Table 8.) Students with frequent numeracy experiences have a mean score (302) higher than students with somewhat frequent numeracy experiences. However, only students with frequent numeracy experiences have a mean score within the Basic range, while the other groups have scores ranging from two to 12 points below the Basic level. This analysis suggests that teaching methods and practices that promote frequent numeracy experiences as defined in this study impact student achievement in mathematics if high standards are also present.

Table 8
Numeracy Experiences of 12th-graders by Race/Ethnicity and Parent Education

	Infrequent Numeracy Experiences (0 to 3)	Somewhat Frequent Numeracy Experiences (4 to 7)	Frequent Numeracy Experiences (8 to 10)
All Students	19%	58%	22%
Mean Score	285	295	302
All White Students	20%	60%	20%
All African-American Students	21%	55%	24%
Students with Low Level of Parental Education	20%	62%	18%
Students with High Level of Parental Education	20%	54%	26%

Shaded cells indicate scores below the Basic level.

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What Can Schools Do to Increase the Frequency of Numeracy Experiences for Their Students?

In the middle grades and high school:

- Have teachers use a problem-solving approach to teach greater mathematics reasoning and understanding.
  - At the beginning of the lesson, pose a real-world problem that can be solved by applying the concepts and procedures being studied.
  - Allow students to struggle with the problem individually and in groups.
  - Give students time to think about how to solve the problem.
  - Ask several students to present ideas or solutions, and engage the class in discussing and identifying the strengths and weaknesses of each proposed solution.
  - Have students summarize the conclusion and work the problem, focusing on procedures and concepts needed to solve it. Provide additional thought-provoking practice problems for students during the remainder of the class and as part of their homework assignment.
  - At the conclusion of each chapter or unit, ask students to find a problem in business class, at the work site, in the community or at home that is an application of what they have just learned. Ask them to write up the problem and prepare the solution for presentation to the entire class.
- Require students to analyze other students' work.
- Rather than having students just solve problems, also require them to explain how they arrived at their solution.

In the middle grades:

- Require mathematics teachers who do not have a major or minor in mathematics to upgrade their content knowledge.[9]
- Have mathematics and other teachers — science, social studies, art, physical education and career exploration teachers — meet regularly to plan lessons that use mathematics knowledge and skills to advance students' knowledge and understanding of their disciplines.
- Designate a mathematics coach who can work with teachers in other classes to devise lessons that integrate more mathematics into their classes.

In high school:

- Have mathematics, science and career/technical teachers meet to identify the mathematical content that is needed to complete science and career/technical assignments.
- Have science and career/technical teachers develop weekly assignments that require students to use mathematics knowledge and skills to complete them.
- Require students to use database and spreadsheet software to complete research assignments in all classes.

[9] *A Highly Qualified Teacher in Every Middle Grades Classroom: What States, Districts and Schools Can Do*, SREB at www.sreb.org.

Extra-help Opportunities and Mathematics Course-taking Patterns

As schools increase standards in mathematics and require students to take more rigorous mathematics courses, some students will struggle. Schools must provide struggling students with the support necessary for success in mathematics so that failure is not an option. By providing students with extra help, schools send the message that *all* students can be successful in challenging mathematics courses and that the school is committed to helping them succeed. The oft-spoken excuse, "Well, I just can't do math" is no longer acceptable. **Students will learn more mathematics by taking more demanding mathematics courses and by working harder than they will by taking less demanding courses and doing less.**

Students enrolled in algebra in grade eight are more likely to receive extra help than students enrolled in lower-level mathematics courses. About three out of four eighth-graders report extra help is not available no matter whether they are taking algebra or not. (See Table 9.) **The situation in these schools leaves many students to fend for themselves in trying to meet higher standards in their mathematics classes and the "Well, I just can't do math" excuse remains acceptable in these schools.** Extra help is effective in advancing achievement when given by the teacher to help students meet standards in higher-level mathematics courses.

Table 9
Eighth-graders' Course-taking Patterns and Reports of Extra Help

	All Eighth-graders	Students Not Taking Algebra	Students Taking Algebra
Eighth-graders Reporting Extra Help Is Available	24%	21%	27%
Eighth-graders Reporting Extra Help Is Not Available	76%	79%	73%

A greater proportion of high school students who complete the recommended curriculum and go beyond it report that extra help is available to them than for students who complete a less demanding mathematics program of study. (See Table 10.) At the high school level, only about one in four students reported that extra help was available to them.

It appears that, in both middle grades and high school, extra help is more likely to be needed and given if students are enrolled in challenging mathematics courses. There is little need to give students extra help as long as they participate in a slowed-down, watered-down, dummied-down mathematics curriculum. Neither the course nor the extra help under these circumstances supports any gains in their achievement. **Then why aren't more students enrolled in higher level mathematics courses and given the extra help necessary to meet course standards?**

Table 10
12th-graders' Course-taking Patterns and Reports of Extra Help

	12th-graders Reporting:	
	Extra Help Is Available	**Extra Help Is Not Available**
All Students	26%	74%
Mean Mathematics Score All Students	304	297
Students Who Complete Less Than the Recommended Curriculum	21%	79%
Students Who Complete the Recommended Curriculum	23%	77%
Students Who "Go Beyond" the Recommended Curriculum	34%	66%

Shaded cells indicate scores below the Basic level.

What Should Schools Do to Provide All Students with Extra Help in Mathematics?

- Assess struggling students on state standards to determine areas of strength and weakness. Provide them with enriched instructional approaches that target students' weaknesses using methods different than those used in their regular classes.
- Require students who are performing below a B level to attend extra-help sessions at least twice a week in grades six through 12, and if possible have it given by their regular mathematics teacher.
- Schedule struggling middle grades and ninth-grade students into career exploratory courses with many mathematics applications, and have mathematics and career/technical teachers work together to create opportunities for students to complete hands-on projects that require the application of the mathematics topics they are learning.
- Pair struggling students with either an adult mentor or another student who will serve as a "study buddy" for those students and encourage them to work hard.
- Offer on a regular basis a support class that provides students with opportunities to work in teams on projects and homework assignments; get help from the support teacher in completing unfinished assignments; and receive instruction on study and social skills. Students will set future goals and build an understanding of what they must do to achieve them. Further, they will take part in self-assessment of their interests and aptitudes.

Transitions To and From High School and Mathematics Course-taking and Achievement

Students who take algebra before grade nine have higher mathematics achievement scores than students who do not take algebra in the middle grades. Yet, 57 percent of the high school students in this study reported that they did not take algebra before grade nine. (See Table 11.)

Students who take mathematics during their senior year have higher mathematics achievement upon leaving high school than students who do not. The data in Table 11 show that their mean score is 301 — four points above the Basic level. Yet the 41 percent of students who did not take mathematics during their senior year have a mean mathematics scores of 293 — four points below the Basic level. **Schools that do not require students to take mathematics during their senior year are doing their students a disservice because their inaction has a negative impact on graduates' mathematics achievement.**

Table 11
12th-graders' Course-taking Patterns and Their Mean Mathematics Scores

	Percentage	Mean Mathematics Score
Took Algebra in the Middle Grades	43%	305
Did Not Take Algebra in the Middle Grades	57%	292
Taking Mathematics as a Senior	59%	301
Not Taking Mathematics as a Senior	41%	293

Shaded cells indicate scores below the Basic level.

Students who take a mathematics course during their senior year are more than twice as likely to complete Algebra III/trigonometry; three times more likely to complete pre-calculus, calculus or advanced placement mathematics; and three and one-half times more likely to take four mathematics credits than students who do not take mathematics during their senior year. (See Table 12.)

Table 12
12th-graders' Course-taking Patterns and Taking Mathematics in Their Senior Year

	Students Who:	
	Take Mathematics During their Senior Year	Do Not Take Mathematics During their Senior Year
Trigonometry or Algebra III	30%	13%
Pre-calculus or AP Mathematics	30%	11%
Students Who Take Three or Fewer Mathematics Courses	30%	80%
Students Who Take at Least Four Mathematics Courses	70%	20%

Shaded cells indicate scores below the Basic level.

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A follow-up study of eighth-graders as ninth-graders found that a little more than half of the students were enrolled in college-preparatory courses in grade nine. Most high-achieving students — those in the top two quartiles on the eighth-grade mathematics assessment — were placed into college-preparatory mathematics classes, yet some were placed into lower-level courses. Many students in the lower two quartiles were placed into higher-level courses and others were not.

Only students placed into higher-level mathematics courses from the lowest percentile had a higher failure rate than did students placed into lower-level courses. (See Table 13.) One-fourth of the high schools enrolled 86 percent of their ninth-graders into higher-level mathematics courses as compared to 51 percent of students at all high schools. The failure rate was no different in the two groups of schools — about 25 percent. **The solution is not to discontinue placing ninth-graders into higher-level mathematics courses, but rather it is to give to them the extra help and support needed to meet course standards.**

Table 13

Ninth-graders Who Earned a "D" or an "F" in College-preparatory and Lower-level Courses by Eighth-grade Test Quartiles

	Lowest Quartile 1	**2**	**3**	**Highest Quartile 4**
College-preparatory Mathematics	43%	28%	15%	10%
Lower-level Mathematics	36%	34%	24%	17%

Guidance and Advisement Experiences and Mathematics Achievement

An analysis of the student surveys indicates that very few students receive any kind of guidance assistance. Two-thirds of eighth-graders reported that they had never spoken with a guidance counselor about planning their high school program of study. Furthermore, only 13 percent of students reported that they and their parents had met with a school representative to plan their high school program of study. This group of students had a lower mean score in mathematics achievement than students who had not taken part in a planning meeting at all.

The percentage of students who report receiving the most help from a teacher and/or guidance counselor in developing a high school program of study does not differ significantly for students in low- or high-performing schools.[10] Moreover, students in low-performing schools are almost twice as likely to say they have participated in a parent-student-teacher conference to plan their program of study as students in high-performing schools. Based on site visits to these schools, it appears that most interactions between parents and the school in the middle grades occur in reaction to other issues, such as disciplinary problems or academic failure. This may explain why low-performing schools conduct meetings with parents more often than high-performing schools and why so few students receive any proactive guidance assistance in planning a program of study for high school. (See Table 14.)

[10]For the purpose of this analysis, "low-performing schools" refers to the bottom 25 percent of schools in the sample and "high-performing schools" refers to the top 25 percent of schools in the sample.

Table 14
Eighth-graders' Guidance Activities in High- and Low-performing Middle Grades Schools

	High-performing Middle Grades Schools	Low-performing Middle Grades Schools
A teacher and/or guidance counselor helped me most in developing my four-year plan of study.	64%	63%
I met with my parents and a counselor and/or teacher to plan my program of study.	10%	18%

At the high school level, four guidance experiences as defined in this study are associated with higher mathematics achievement. (See sidebar.) In these 24 rural districts, about one in five students do not have any of these four experiences. The mean mathematics score of these students is 294 — 3 points below the Basic level. (See Table 15.) On the other hand, the 13 percent of students who received more guidance services had a significantly higher mean mathematics score of 310 — in the mid-range of the Basic level. Only 23 percent of students reported being encouraged to take more challenging mathematics courses and these students had a mean mathematics score of 308 as compared to students who were not encouraged who had a mean score of 290. More African-American students have no guidance experiences as compared to White students. **Unfortunately these schools are failing to provide many students and their families with the guidance and advisement necessary to make informed decisions about which mathematics courses students should take and why.**

High School Guidance Experiences

- I was encouraged to take more challenging mathematics courses.
- I received the most help in planning my high school program of study before grade nine.
- My parents and I met with a school representative to plan my high school program of study.
- I received information from the school about postsecondary education and employment.

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Table 15
12th-graders' Guidance Experiences by Race/Ethnicity and Parent Education

	No Guidance Experiences (0)[1]	Some Guidance Experiences (1 to 2)	Several Guidance Experiences (3 to 4)
All Students	22%	65%	13%
Mean Score	294	298	310
All White Students	21%	66%	13%
All African-American Students	29%	59%	12%
Students with Low Level of Parental Education	24%	66%	10%
Students with High Level of Parental Education	20%	64%	16%

Shaded cells indicate scores below the Basic level.

[1]For the purpose of this study, the numbers in the parentheses refer to the list of four high school guidance experiences. See sidebar on page 15. For example, in Table 15, "0" means none of the guidance experiences listed, "1 to 2" means one to two of the experiences listed, and so on.

What Can Schools Do to Help All Students and Their Families Make Better Course-taking Decisions?

In the middle grades:

- Have parents and students meet with a teacher or counselor annually to discuss the importance of working hard and taking the "right" mathematics courses.
- Target students in the seventh and eighth grades who are at risk of not being prepared for Algebra I in high school, and provide them with three years of mathematics instruction during the last two years of the middle grades.
- Create a four- to six-week summer "bridge" program for incoming ninth-graders who need further study to succeed in high school Algebra I. Have the strongest teachers teach in this program and provide students with instructional experiences that show the need for mathematics and with instruction on good study skills.

In high school:

- Require all students to take a high-level mathematics course during their senior year.
- Have a local college administer its mathematics placement exam to all 11th-graders as a reality check. Schedule those students who would have to take remedial courses in a double dose of mathematics during their senior year.
- Enroll students who have scored below the state average on the SAT or ACT in a double dose of mathematics in their senior year.

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Summary

Many of the students in this study enter high school unprepared for college-preparatory mathematics, and many more graduate from high school without adequate mathematics skills and knowledge to get good jobs in today's economy or to enter postsecondary programs of study without remediation. These rural schools at both the middle grades and high school levels are not doing enough to actively engage students in mathematical learning, to provide needed extra help and support, to guide and advise them and their parents in planning a course of study, and to create a climate of high expectations. **Most importantly, the level of rigor and quality of instruction is very uneven — especially for African-American students.**

Middle Grades Performance Levels for Mathematics

Students performing at the Basic level:

Basic (mean score 143-177)

- are able to work with the four arithmetic operations in one- or two-step word problems;
- are able to recognize pictorial representations of fractions, read rulers and scales and recognize which units of measurement are most appropriate for a given situation;
- can identify geometric shapes and properties of those shapes and can visualize transformations of figures;
- are able to construct graphs and can read and interpret information from graphs;
- are able to work with simple probabilities and can find the mean of a set of numbers;
- can extend simple number patterns, work with positive and negative numbers, evaluate simple expressions and solve equations with one variable;
- are beginning to develop an understanding of representation by locating ordered pairs on a coordinate grid and by constructing number sentences;
- lack a conceptual understanding of many fundamental mathematical concepts; and
- cannot do simple reasoning and problem-solving strategies.

Students performing at the Proficient level:

Proficient (mean score 178-209)

- possess a working knowledge of many fundamental mathematical ideas and are beginning to interpret and apply concepts and abstract ideas;
- are able to work with problems containing more than one or two pieces of mathematical information;
- generally exhibit an emerging knowledge and understanding of more formalized algebra topics;
- are able to use reasoning in their numerical computations and in working with data in order to interpret their results in the context of the problem;
- can extract information from graphs and combine that information with their knowledge of other topics in mathematics to solve a problem;
- are able to work with measurement topics that incorporate several ideas;
- can work with representations to perform operations, such as combining like algebraic terms and solving linear equations in two variables; and
- are beginning to develop an understanding of algebraic identities.

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Students performing at the Advanced level:

Advanced (mean score 210 and above)

- are able to work confidently with abstract representations of fundamental mathematical concepts;
- can work effectively with whole numbers, integers, rational numbers and their equivalents;
- are developing mathematical reasoning processes and analysis techniques in order to solve more complex problems;
- may be able to use a more efficient solution strategy if one is available;
- are able to utilize properties in geometry to analyze geometric situations and can begin to recognize the formal structure of geometry;
- possess a thorough understanding of patterns, such as the ability to generalize patterns, construct algebraic representations of patterns and work with complex patterns involving multiple operations that may include powers; and
- may be successful in solving some types of non-routine problems.

High School Performance Levels for Mathematics

Students performing at the Basic level:

Basic (mean score 297-327)

- possess an understanding of simple mathematical concepts and are able to perform basic arithmetic operations;
- are beginning to utilize elementary reasoning techniques to solve straightforward problems;
- are able to process only a limited amount of mathematical information in a problem at one time;
- are rarely able to employ more complex solution methods if the problem requires them;
- are able to use their knowledge of procedures and elementary concepts to solve one- or two-step word problems;
- can perform simple measurement tasks and can work with metric units of measure;
- understand the properties of triangles and quadrilaterals and can identify lines of symmetry on geometric figures;
- can visualize geometric figures in two and three dimensions and may be able to reason spatially using properties of those figures;
- can read and interpret graphs, compute with data from tables and graphs and answer simple conditional probability questions;
- have acquired a procedural understanding of algebra; and
- can construct simple algebraic representations and extend numerical patterns.

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In addition to the Basic skills and knowledge, students performing at the Proficient level:

Proficient (mean score 328-348)

- are beginning to demonstrate evidence of the use of analysis techniques and more sophisticated reasoning skills in their solutions to mathematics problems;
- can solve problems that require the integration of more than one mathematical idea or strategy and check their answers for reasonableness;
- may demonstrate an emerging understanding of mathematics as a process;
- are able to use their knowledge of number theory to work with prime numbers and even and odd integers;
- can approximate square roots and compute with fractions and percents (including percents greater than 100) in several contexts;
- can work with scale drawings, and successfully solve problems involving non-routine applications of area and employ more sophisticated spatial reasoning techniques;
- are able to identify a correct statistical sampling method and can use a given probability to determine missing data in a question;
- understand linear functions and are beginning to work with nonlinear functions, such as exponential relationships;
- are able to solve a system of two linear equations using simple elimination, relate integers to real-world situations, and work with distance and slope in a coordinate system;
- have a better understanding of the underlying concepts of linear functions than the underlying concepts of nonlinear functions; and
- are more likely to draw on their knowledge of procedures when working with nonlinear functions and may experience difficulty in applying concepts involving nonlinear functions in problems.

In addition to Basic and Proficient skills and knowledge, students performing at the Advanced level:

Advanced (mean score 349 and above)

- have generally acquired a certain level of sophistication in being able to understand and utilize the notation, reasoning and processes of mathematics;
- are beginning to make important connections within mathematics and between mathematics and other areas, to work with non-routine applications in problem settings, and to make predictions;
- regularly evaluate their work and answers for reasonableness as their approach to the study of mathematics becomes embedded in sound processes and practices;
- can readily recall and utilize appropriate formulas in a variety of problems;
- can solve a system of two linear equations using methods beyond one-step elimination, work with multiple representations in algebra and possess a strong conceptual understanding of fundamental algebraic concepts; and
- are able to work with non-routine problems across various content areas, such as solving problems about piecewise functions, cross-sections of three-dimensional figures, mathematical sequences and precision/tolerance.

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Southern Regional Education Board Goals for Education

1. All children are ready for the first grade.
2. Achievement in the early grades for all groups of students exceeds national averages and performance gaps are closed.
3. Achievement in the middle grades for all groups of students exceeds national averages and performance gaps are closed.
4. All young adults have a high school diploma — or, if not, pass the GED tests.
5. All recent high school graduates have solid academic preparation and are ready for postsecondary education and a career.
6. Adults who are not high school graduates participate in literacy and job-skills training and further education.
7. The percentage of adults who earn postsecondary degrees or technical certificates exceeds national averages.
8. Every school has higher student performance and meets state academic standards for all students each year.
9. Every school has leadership that results in improved student performance — and leadership begins with an effective school principal.
10. Every student is taught by qualified teachers.
11. The quality of colleges and universities is regularly assessed and funding is targeted to quality, efficiency and state needs.
12. The state places a high priority on an education system of schools, colleges and universities that is accountable.

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